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DEPARTMENT OF COMMERCE
UNITED STATES BUREAU OF MINES
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DESIGN, EQUIPMENT, AND CONSTRUCTION COSTS OF THE DAVIS-DUNKIRK CONCENTRATOR, PRESCOTT, ARIZ.[1]

By E. L. Sweeney[2]

INTRODUCTION

The mine and mill of the Davis-Dunkirk Mines, Inc., are about 15 miles by road south of Prescott, Ariz., which is the nearest railroad point for receiving mine and mill supplies and for shipping concentrates to smelters. A good trucking road reaches within 2 miles of the property, but from that point the grade is very steep. Outgoing loads are limited to 2 tons.

The topography near the mine is exceedingly rugged, and the area is slightly wooded. The climate is mild excepting in a few winter months, when the snowfall is heavy.

Electric power is secured by way of a 4 1/2-mile, high-tension line connecting with the main line of the Arizona Power Co.

The concentrator was intended to treat 60 tons or more daily of gold-silver-copper ore and make a single gold-silver-copper concentrate for shipment to a copper smelter.

DESIGN OF CONCENTRATOR

Figure 1 shows the flow sheet of the concentrator.

It was apparent from the nature of the ore that flotation was the most suitable method of concentration. Tests showed that any of the common types of flotation cells would give both a satisfactory grade of concentrate and a high percentage of recovery. The flotation cells are placed so that other arrangements such as the more usual rougher-cleaner set-up may be adopted if desired.

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1 The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is used: "Reprinted from U. S. Bureau of Mines Information Circular 6730."

2 Mining engineer, and one of the consulting engineers, U. S. Bureau of Mines.

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The crushing and grinding units indicated on the flow sheet were selected because the writer's experience in several mills of 50 to 150 tons daily capacity shows that secondary crushing is uneconomical in such plants. The crusher is capable of reduction to 1 1/2-inch size, and the presence in the ball-mill feed of some slab-shaped rocks larger than this in one or two dimensions is not harmful because of the relatively great length of the mill, especially if the density of the mill discharge is properly controlled. The ball mill is driven by a V-rope drive.

Filter concentrates are discharged directly on a drying floor that is roofed over but provided with only low sides. A trapdoor discharges the concentrates from the drying floor into trucks.

No water is recovered from the tailings excepting the overflow of the thickener.

The mill is so compact that two men on each shift can operate not only the milling and concentration sections but the crusher, and in addition the mine compressor, which is installed alongside the mill.

The mill building is 30 feet wide and 55 feet long, comprising a grinding floor 20 feet long, a flotation floor 15 feet long, and a filter and thickener floor 20 feet long. The total floor area is 1,650 square feet. Little extra space was provided, excepting that a small warehouse was built at the level of the grinding floor for storage of oils, reagents, and other supplies, and ample space was also provided at that point for storage of other materials and for repairs.

As the excavation was largely in solid rock, only the thinnest practicable concrete walls were needed between the different floors. Twenty-four gage corrugated iron was used for roofing, and 26 gage for siding.

Because of the small size of the mill and the cost of freighting, timber construction was preferred to steel. The building is strongly designed, with special provision for snow load. Both coarse- and fine-ore bins are of timber construction. The grizzly and crusher are placed on top of the fine-ore bin.

Lighting is provided for by common double-sash windows and flood lights on each floor. No heating is provided for.

EQUIPMENT

The equipment used was chiefly new; nevertheless, a considerable saving was made by purchasing some equipment from a small flotation plant that had been run not more than five weeks. These items are indicated in the following tabulation which shows mill equipment costs, f.o.b. factories:

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Mill equipment costs, f.o.b. factories

Items	Cost	Cost if new
1 grizzly, bar type, 3 by 6 feet by 1 1/2 inches	$ 30	$ 70
1 coarse crusher, 9 by 21 inches	1,750	1,750
1 feeder, belt type, 16 inches by 12 feet	125	250
1 ball mill, 4 1/2 by 8 feet	2,800	2,800
1 classifier, 4 1/2 by 20 feet	800	1,650
2 flotation machines, McIntosh, 10 feet	600	1,600
1 concentrate thickener, 16 feet	889	889
1 filter, drum type, 3 by 4 feet	1,060	1,950
1 Dorrco pump, 2 inches	260	260
1 tailing thickener, 30 feet	1,613	1,613
1 blower	572	572
2 pumps, Wilfley, 2 inches	200	350
3 reagent feeders	100	300
6 motors, starters, etc.	2,109	2,109
Drives	1,412	1,412
Ball load	500	500
Tools for mill operation	300	300
Total cost of equipment	15,120	18,375
Cost of equipment per ton of daily capacity (75-ton basis)	202	245

SELECTION OF MILL SITE

All of the area near the mine is too steep for an ideal mill site. Although the point selected, about 250 feet from the mine adit, is the flattest site available, the mill floors have too great differences of elevation and require more excavation than is usual on flatter sites. Other factors influencing the choice of a site were water supply, tailings disposal, and transportation, or road-building. At the place chosen, the mill water can be run by gravity into storage tanks just above the ball-mill floor. The topography is too steep for convenient tailings disposal, yet it is necessary to avoid stream pollution. An area was found a few hundred feet downstream from the mill where tailings could be banked on the hillside. In operation the cost of tailings disposal is $0.12 per ton. At the mill site selected it was possible to build branch roads to the head of the mill, to the ball-mill floor, and to the concentrate drying and storage platform.

CONSTRUCTION

The plant was completed in 82 working days, in spite of bad weather and an unusually heavy snowfall which hampered the work.

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Construction costs were increased by several other factors: All sand and gravel had to be trucked from Prescott; getting heavy equipment from trucks onto the various mill floors was most difficult; the design called for unusually heavy construction; and speed was desired.

Millwrights and mechanics received $8 and common labor $5 for 8 hours.

The building and bin unit costs were as follows:

	Per square foot	Per cubic foot
Mill building only	$ 1.42	$ 0.065
Mill building and bins	1.08	.050

Details of construction costs, including everything but design and equipment, were as follows. All building material, electrical equipment, and piping were new.

Details of construction costs

Rock excavation, 770 cubic yards (in place) at $2.58 per yard	$ 2,006
Earth excavation, 600 cubic yards (in place) at $0.50 per yard	300
Concrete, 78 cubic yards at $18.00 per yard	1,404
Mill building and bins, erected	2,340
Piping	1,256
Wiring	1,150
Water tanks (two 16-foot)	470
Freight on equipment	1,663
Freight on supplies	297
Trucking from Prescott to mill site	901
Setting machinery (including moving from trucks)	3,531
Total	15,315

The total cost of the mill as erected, with some used equipment, was $30,435, or $406 per ton of daily capacity (75-ton basis).

If all new equipment had been used the cost would have been $33,690, or $449 per ton.

OPERATION

The average capacity of the plant proved to be 75 tons per 14 hours. The cost of milling to date (January 1932) has been $1.23 per ton and the percentage recovery 93.8. The average ratio of concentration has been 8.5 into 1. Concentrates shipments have averaged 3.5 percent moisture.

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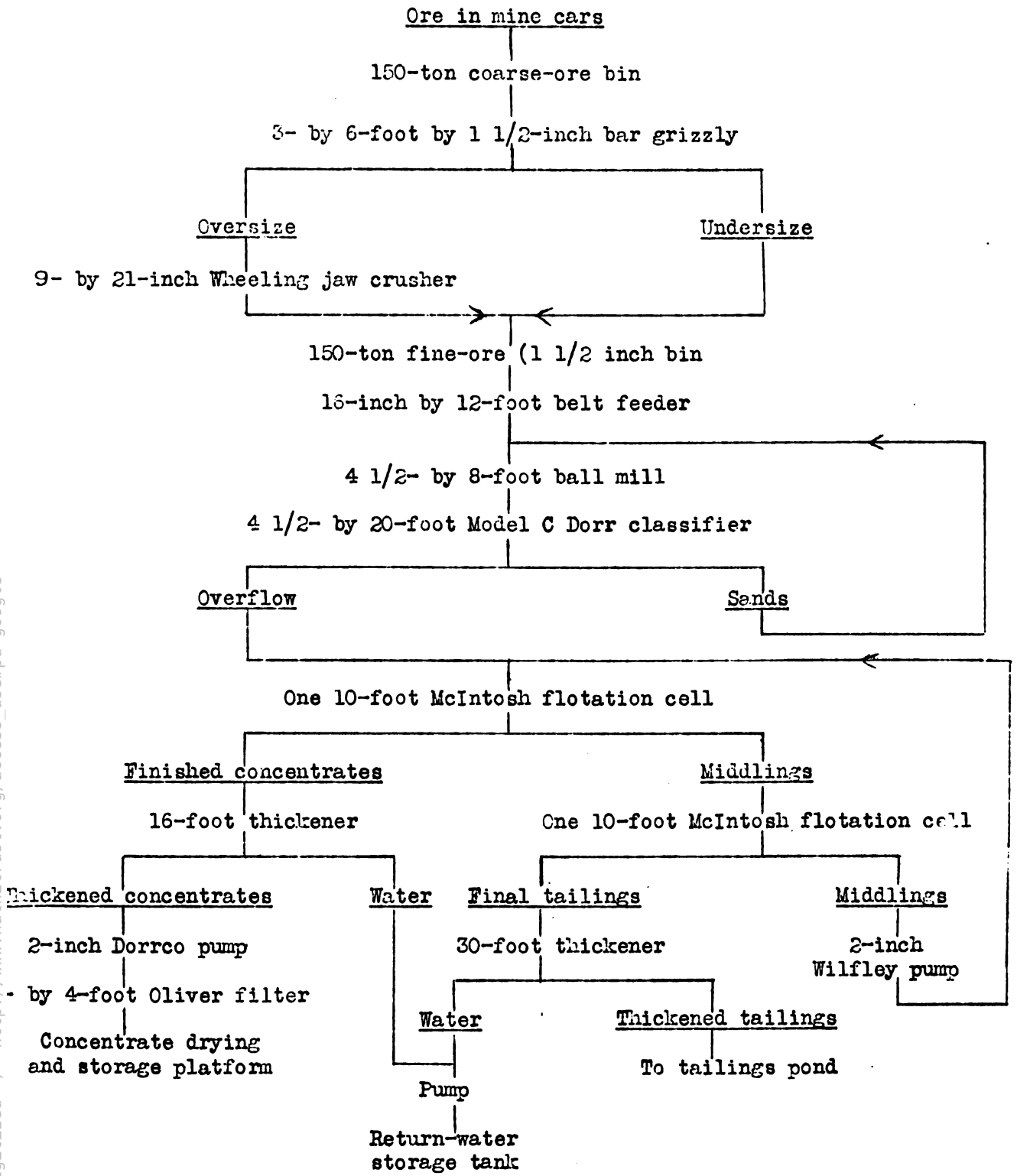

Figure 1.--Flow sheet of Davis-Dunkirk mill.

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